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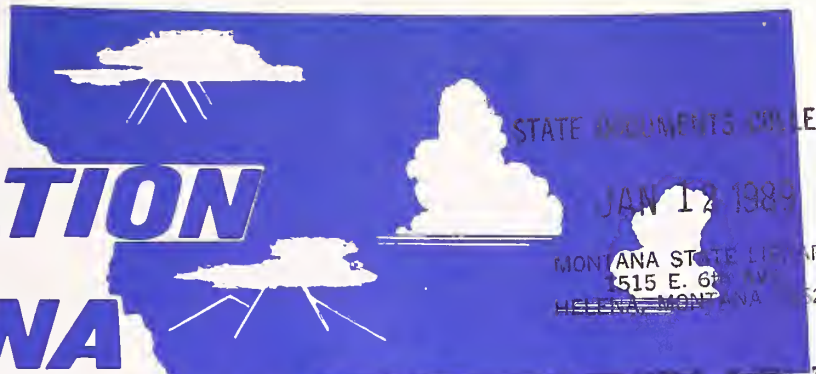
WEATHER MODIFICATION IN MONTANA



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HIPLEX UPDATE

Last summer marked an important stage for **HIPLEX (High Plains Cooperative Program)** weather modification research at Miles City, Mont. Using background knowledge gained during past years, scientists designed and initiated a randomized cloud seeding experiment. Designated as **HIPLEX-1**, this work is significant because researchers will be collecting information needed to confirm the effectiveness of summertime cloud seeding. Without this study of randomly seeded clouds it would be difficult, if not impossible, to prove that cloud seeding increases rainfall.

The HIPLEX-1 experiment deals with small cumulus clouds classed as *cumulus congestus* or, more commonly, towering cumulus. These are relatively small clouds that often produce little or no rain naturally. The clouds studied had to be less than five miles (eight km) in diameter and have a base temperature warmer than freezing with the tops no colder than -4°F (-20°C). Also considered in cloud selection were liquid water content, ice concentrations, updraft strength, and distance from nearby clouds. Those clouds detected by the radar were avoided because the presence of ice particles was indicated and, therefore, natural rainfall was likely. By using this rigid selection process, the researchers were not only able to deal with similar clouds but could make their studies before the natural rainfall process began.

The selection of the clouds requires aircraft flights to parts of the HIPLEX study area where likely clouds have been observed from the ground. Once in the test area, a meteorologist aboard a cloud physics aircraft visually selects a suitable cloud. Final determination of whether the cloud is suited for study requires a flight through the cloud so that the needed measurements can be made. Once the measurements are made, a computer on the aircraft calculates whether the cloud meets the strict selection criteria.

The Random Seeding Process

To determine whether summer cloud seeding is effective, researchers must avoid biasing their results by an unconscious tendency to favor the seeding of clouds which may have a slightly better chance of producing rain. Further, they wish to eliminate the human tendency to bias their observations by having prior knowledge of whether seeding will take place. Both of these biases are avoided by randomly selecting clouds to be treated with the dry ice seeding agent.

The random selection process begins after a cloud has been found suitable for study and requires the use of two dry ice dispensers on the jet seeding aircraft, one of which is made inoperative by a ground crew just before each flight. The decision on which dispenser to deactivate is made randomly by the ground crew, much like flipping a coin. Even though the jet is flown through each suitable cloud and one of the dispensers is activated, only the ground crew knows which one is functional. Thus, bias is removed from the study, because the observing scientists do not know whether a particular cloud has been seeded or not. That is revealed later and not until all the needed information has been collected.

The lifetime of towering cumulus clouds is short, limiting the amount of time seeding can be effective. Because of that, all evaluations must be made quickly and activities must be closely coordinated. Within two minutes after the cloud physics aircraft has declared a cloud suitable for seeding, the jet aircraft must make its "treatment" pass through the cloud. Once the jet has completed its run, the cloud physics aircraft must measure the cloud's characteristics during a precise series of flights, ending at the base of the cloud. At the same time, the jet remains near the top of the cloud to observe any changes at that level. All information collected by the aircraft is supplemented with ground radar observations noting the timing, amount and intensity of any precipitation.

Measurements are made on each test cloud until it has dissipated or until 40 minutes after the treatment pass, whichever comes first. Because of the rigid selection process and the time required to make the needed measurements, no more than a few clouds can be sampled on any given day. This past summer was drier than normal and generally lacking in clouds qualifying for the study. As a result, only 12 clouds were studied as part of the HIPLEX-1 experiment, which began on June 21 and extended through the end of July.

Other HIPLEX Summer Activity

Although the HIPLEX research this year was focused on the HIPLEX-1 experiment, the scientists dealt with a number of other activities. Included was a study of the number and characteristics of larger storm systems that either developed in or moved

(continued on back page)

CITIZEN PARTICIPATION SOUGHT IN HIPLEX OPERATIONS

The science of weather modification still faces many unanswered questions. The objective of the HIPLEX program is to overcome scientific uncertainties over seeding clouds to increase growing season precipitation. A great deal of progress has been made toward that objective. These advances are crucial to the proper development and application of the necessary technology. However, the final success of these efforts depends on the actions and attitudes of the people who are affected by the research program—people who, in time, must decide how this technology will be put to use.

Greater citizen participation in decisions that concern the HIPLEX program, as well as weather modification in general, is an important need, recognized by the Montana Department of Natural Resources and Conservation. In response, the Department expects to appoint a weather modification advisory committee. As representatives of the citizens who are most affected by the HIPLEX research, the committee members will actively participate in the HIPLEX decision making process and are expected to play a key role in the development and use of weather modification in Montana. The committee will consist of a county commissioner or designated representative from each of the following eastern Montana counties: Carter, Custer, Dawson, Fallon, Garfield, McCone, Powder River, Prairie, Rosebud, Treasure and Wibaux.

The advisory committee will meet regularly with the HIPLEX staff in Miles City and assist in answering such questions as:

- Do citizens of eastern Montana feel they have sufficient knowledge to make decisions regarding the use of weather modification?
- Do citizens understand the potential risks of seeding larger scale weather systems? Are they willing to accept these potential risks?
- What aspects of the HIPLEX research, and weather modification in general, are of greatest concern to people in eastern Montana?
- When and where would additional precipitation through weather modification be most beneficial?
- At what times would additional rainfall create problems, and conflict with such activities as planting or harvesting?
- Does the HIPLEX research adequately deal with the questions that citizens have about spring-summer cloud seeding?

In order to deal effectively with these issues, the advisory committee and the general public must have reliable information on the risks, rewards, problems and prospects of weather modification. To meet this information need, the Miles Community College and the Department of Natural Resources and Conservation are planning to hold a series of forums on weather modification. Subjects that could be discussed include:

- HIPLEX research
- cloud seeding techniques
- the social, legal, environmental and economic implications of weather modification
- policies relating to the development and use of this technology

It is hoped that through such forums, the citizens of eastern Montana will become better informed about weather modification and, along with the weather modification advisory committee, play an active role in shaping the way this promising technology is developed and put to use.

Funding needed to conduct these forums is now being sought from the National Science Foundation (NSF) in Washington, D.C. A preliminary proposal, submitted by Miles Community College, was judged appropriate for funding consideration and NSF has requested a final proposal. The final proposal was sent to NSF in mid-September, and a reply is expected in the spring. If the project is funded, the series of forums will begin in the late fall of 1980.

AUTOMATED WEATHER STATIONS TO MONITOR EASTERN MONTANA WEATHER

Next summer about 50 automated weather stations, designed for the HIPLEX weather modification research program, will be installed throughout eastern Montana. The group of stations will be used to gather detailed information on atmospheric conditions leading to the clouds that account for most of the rainfall in eastern Montana. Atmospheric scientists refer to these thunderstorm-size cloud systems as being mesometeorological in scale (meso means middle). Hence, this network of new weather stations has been termed the "mesonet" (*meso*meteorological *net*work).

During the next few years, HIPLEX researchers will continue to focus on small clouds, attempting to understand how to produce rainfall through cloud seeding. At the conclusion of this work, the researchers expect to apply the findings to a study of larger weather systems which have a greater rain producing potential. In order to do so, they must now begin to acquire a more thorough understanding of these large systems. The mesonet will be one of the "tools" used to gain this knowledge.

Past research has indicated that studies of detailed information on weather conditions near the ground may be an important way to understand what causes these large storms to develop. This information may also help predict the size and effects of the storms. Therefore, HIPLEX scientists will use the mesonet stations to record atmospheric conditions occurring near the ground as these weather systems develop overhead. They will also compare these findings with information obtained from the same storm systems gathered by aircraft instruments and weather radars. In making these studies the scientists will be looking for ground-level conditions that tend to occur during the development of different types of weather systems. At the same time they will be looking for specific weather conditions near the ground that correspond with the occurrence of rainfall. By making this evaluation, the researchers expect to develop a capability for predicting thunderstorm-size cloud systems. This will aid in designing and evaluating a future HIPLEX cloud seeding experiment that deals with such storms.

CANADA JOINS IN HIPLEX RESEARCH

In early July, 12 Canadians arrived in Miles City to begin working alongside the United States HIPLEX researchers on ways to increase rainfall during the spring-summer growing season. Their participation in the weather modification research was the result of a special agreement between agencies of the Canadian government and the Water and Power Resources Service (formerly the U.S. Bureau of Reclamation), the sponsor of HIPLEX. These atmospheric scientists and technicians represented the Canadian Atmospheric Environmental Service and the National Aeronautical Establishment.

During its month-long stay, the Canadian team used sophisticated electronic instruments on a cloud physics aircraft to study the clouds and cloud systems found in the HIPLEX study area. On several occasions, the Canadian aircraft was direcly involved in the actual cloud seeding experiments. During these flights, scientists on the HIPLEX and Canadian cloud physics aircraft monitored the changes in cloud characteristics following the actual or simulated seeding.

An interior view of the Canadian aircraft shows some of the sophisticated electronic equipment used in gathering and analyzing weather data.

Members of the Canadian atmospheric research team gathered near their Twin Otter cloud physics aircraft shortly after arriving at Miles City.

Canadian prairies and the high plains region of the United States both suffer from frequent dry spells during the growing season. As a result of participating in HIPLEX, the Canadian scientists will be better able to determine whether the technology being developed in Montana can bring rain to the crop lands of the Canadian high plains.

As participants in HIPLEX, the Canadian researchers shared the learning experience, and contributed important experience, knowledge and equipment to the project. HIPLEX site director Arlin Super said he was pleased with the Canadians' role in this year's field operations. He added that the overall research effort at Miles City benefitted considerably from the expertise of the Canadian scientists and the additional cloud physics data obtained from their flights. "I expect that in future years we will see a similar Canadian-United States cooperative effort take place in Miles City," he said.

"The fact that the Canadian aircraft could be used in our studies allowed us to obtain important information that otherwise could not have been collected," Super commented. "Working together, as we did this past summer, will very likely result in quicker solutions to a problem which is common to both countries."

One of the mesonet stations that will be used by HIPLEX scientists to collect information on wind speed and direction, temperature, pressure, humidity, and precipitation.

There are several special features of these weather observation stations which should allow the HIPLEX scientists to obtain the specialized information they need. First, the stations are fully automatic and able to make a number of important measurements with precision. Second, the systems are powered by batteries that are recharged by a panel of solar electric cells, permitting the collection of continuous data. Third (the most interesting aspect of these stations), they relay the collected information to the researchers in Miles City via satellite. Every hour, each station will transmit its data to a satellite whose orbit corresponds to the rotation of the earth. The satellite then relays the information to a special receiver at Wallops Island, Va. From there, through a series of computer links, the information is transmitted across the United States to Miles City. Using this space-age data transmission system, HIPLEX scientists will be able to study the weather information gathered by all of the remote stations within an hour after it is observed.

The overall HIPLEX research takes place within a 90-mile (150-km) radius of Miles City. The 50 remote weather stations available have limited the area which can be covered by the mesonet to the portion of the HIPLEX study area which is shown on the map on the back page. Individual stations will be spaced about 12 miles (20 km) apart, forming a 60-by 85-mile (100 x 140 km) grid pattern. They will be located on the land of eastern Montana farmers and ranchers whose cooperation is making this important part of the HIPLEX research a reality.

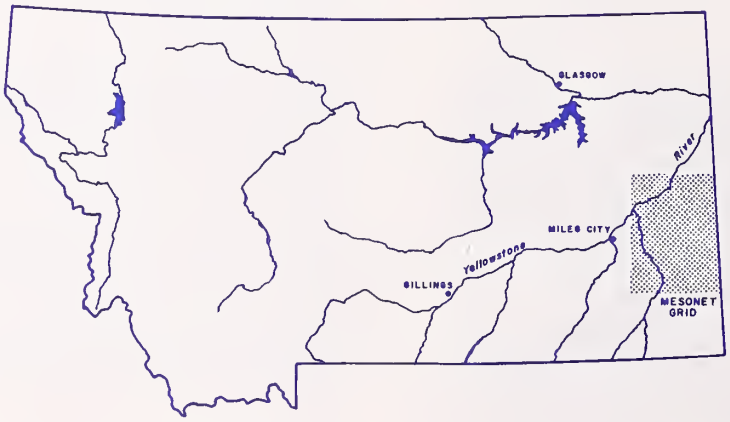
through the study area. This evaluation required the daily operation of the research radar from mid-morning until after sunset and, at times, use of the cloud physics aircraft. Several large storm systems were investigated, and the information will be used in planning future experiments on these more complex weather systems. This type of storm accounts for the majority of rainfall in eastern Montana and will be the object of intensive study after the HIPLEX-1 experiment is completed.

A question often asked when the subject of weather modification is discussed is: "Does the seeding of clouds change the rainfall patterns over land downwind from an intended target area?" HIPLEX research is addressing this question at a special test site downwind of the seeding experiments near Baker, Mont. Using radar and instruments carried by weather balloons, scientists gathered information that, in time, will aid in answering the question of downwind seeding effects. In addition to this study, the Baker radar installation aided in collecting information on the size, development, and movement of the large weather systems. A portion of this work involved the use of a HIPLEX cloud physics aircraft during August for investigating the characteristics of several large storms which moved into the Dakotas from Montana.

The participation of the Canadian government in HIPLEX research was another significant aspect of the activity this past summer. (See **Canada Joins in HIPLEX Research**.) Testing of the automated weather stations that were recently developed for use in next year's mesonet studies was a similarly important endeavor. (See **Automated Weather Stations to Monitor Eastern Montana Weather**.) Studies to assess the biological impacts of increased rainfall from cloud seeding continued through the summer and will be explained in an upcoming issue of this newsletter.

HIPLEX scientists are pleased with the operations during this past field season and are looking forward to the study of larger weather systems. To study such systems, the effects of seeding the small clouds must first be confirmed and a greater number of clouds must be studied during the HIPLEX-1 experiment. Therefore, although the work is promising, this important phase of the HIPLEX program must continue for about two or three more years.

Location of Mesonet Grid



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